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ABSTRACT

The purpose of this study was to determine the effects of self-pacing instruction in a science methods course on teachers' achievement and attitudes toward science. A second purpose was to examine "open and closed" mindedness and achievement in science methods instruction. Twenty pre-service elementary school teachers were randomly selected and assigned to two treatment groups. One group received self-pacing instruction; the other group was taught in a normal classroom setting. Both groups received science instruction based on a modular package. The research design used is the one proposed by Campbell and Stanley as the Post-Test Only Control Group Design. Data were analyzed by t-test and Pearson product-moment correlations. The results indicate that teachers who were taught utilizing a self-pacing technique did not achieve significantly better or have attitudes that were different from those who were not self-paced. These results indicate the need for educators to examine self-pacing under different learning environments. (Author/BR)

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THE EFFECTS OF SELF-PACING SCIENCE METHODS INSTRUCTION ON ATTITUDES AND ACHIEVEMENT OF PRESERVICE TEACHERS*

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Teacher preparation is one of the most difficult problems facing educators today. This stems mainly from four basic reasons. First is the lack of adequate research due to the multitude of variables one has to work with; second, research if often times conducted in a laboratory setting, and thus, it has no application to real life situations; third, there hasn't been much useful research which deals with teacher behaviors and student achievement (B. O. Smith, 1970); and finally, most teacher education programs lack clear goals (Krug, 1972).

The problem with most traditional teacher education programs has been the formal setting in which the trainee takes a pattern of general education courses which would be required of all students. Further, pedagogically, all instruction has been the usual lecture-demonstration type and provided no opportunity for the trainee to receive any kind of worthwhile feedback. The only significant exception in the traditional teacher training program has been student teaching.

The above discussion has shown that teacher education is a most urgent problem and a better way of training teachers

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is needed. Not only should mechanisms be devised such that teachers are required to demonstrate knowledge in teaching skills, but ones which also requires them to demonstrate their effectiveness in executing learned skills in classroom settings with students as well. Such a teacher education program which has been proposed and began to receive attention in the latter half of the 1960's is called Competency-Based or Performance-Based Teacher Education. Competency-Based instruction is a method that is believed to be effective for teacher training. This is evident in the volume and nature of the literature on competency-based instruction found in educational journals in the last seven years.

Competency-based instruction encompasses several unique components (for a list of these see Tobey, 1974). One of these components is self-pacing. Research studies on self-pacing are contradictory. In one study Edwards and Powers (1973) found that there were no significant differences in achievement of students who studied in a self-pacing setting when compared to those who studied in a group interaction setting. Calhoun (1973), found that students who studied in a self-pacing approach achieved significantly better than those students who studied in an instructor-based approach. Yeazell, Nordi, and Franklin (1974) found that when students studied in a self-paced instructional setting in a criterion multimedia educational psychology course, they performed significantly better in the total course than those students not using this approach.

The major purpose of this study was to determine what effects self-pacing would have on students' achievement of science process skills. The dependent variable was students' achievement on two science process skills tests. Another purpose of the study was to determine if students' attitudes toward science could be altered using self-paced instruction.

PROCEDURE

Preservice teachers (n=20) enrolled in a science methods class that combined science methods instruction with field-based learning experience were the subjects for this investigation. The subjects consisted of nineteen females and one male. All subjects were either juniors or first semester seniors. The twenty teachers were randomly assigned to one of two groups. One group was selected as the treatment group and received self-pacing instruction. The other group was taught in the traditional instructor-pace kind of setting.

Instruction for both groups was based on a modular package. The package consisted of four modules that were designed to help teachers learn to implement science process skills and plan science units. The topics included in the modules are: (1) What is Science, (2) Science Process Skills, (3) Science Curriculum Materials and (4) Community Resources. For the purpose of this investigation only the module dealing with science process skills was used as a basis for gathering and reporting results. Each module contained an introduction,

goal, tasks(s), enablers and instructional resources. In addition to being given a modular package, each student studied two self-instructional programs called Science Process Skills (Okey and Fiel, 1972). The instructional programs consisted of objectives, practice exercises, feedback on exercises, self-test and answers. Objectives stated in the program cover such topics as measurement, classification, constructing a graph and identifying variables.

All twenty subjects completed the Rokeach Dogmatism Scale (Form E). The scale is a 40 item Likert-type measure and is designed to determine the degree of open-mindedness a subject has (Rokeach, 1960). A high score on the Rokeach scale indicated a student was closed-minded, while a low score indicated a student was open-minded. The Rokeach scale was administered to determine if those subjects who were considered open-minded would have more favorable attitudes toward teaching science and also to determine if they would perform significantly better on science process skills achievement tests than those considered closed-minded. In addition to completing the Rokeach scale, all subjects took the Moore and Sutman (1970) Scientific Attitude Inventory and an achievement test on process skills.

The Scientific Attitude Inventory (SAI) consisted of 60 items and was designed to measure students' attitudes toward science. Examples of items included on the scale are: I

would enjoy studying science and using this knowledge in some scientific field and scientific explanations can be made only by scientists.

The achievement test was administered upon the completion of instruction and was based on performance objectives for the process skills instruction.

Although only the process skills achievement tests were used as a means for reporting results for this investigation, subjects in both groups were required to complete the aforementioned modules using either self-pacing or an instructor-paced approach. At the beginning of the summer quarter, subjects were assigned to either a self-pace group or instructor-pace group. The latter group was given specific instructions on dates when tasks were to be turned in, while subjects in the self-pace group were told to turn in tasks whenever they completed them. Both groups, though, were told that they had only until the end of the quarter for completion of the tasks if they expected to receive a grade for the course. The experimental design employed is a Posttest-Only Control Group Design (Campbell and Stanley, 1963).

ANALYSIS AND RESULTS

The effects of self-pacing on achievement of process skills and attitudes toward science were measured. In order to compare the scores of the treatment and control groups on the three dependent variables, t-tests were calculated.

Pearson product moment correlation coefficients were calculated using the dogmatism scores with the three dependent variables.

Table 1 contains data from experimental and control groups on the three dependent variables.

TABLE 1

Comparison of Experimental and Control Groups on the Three Dependent Variables

Criterion Measure		BSPS Test Scores	ISPS Test Scores	SAI Scores
Experimental Group	X	89.50	92.30	108.50
N = 10	SD	12.03	6.89	9.99
Control Group	X	83.40	85.30	110.10
	SD	13.12	13.20	14.73
t		1.19	3.66*	2.18

*$p<0.06$

Although no statistical significance resulted on the basic science process skills (BSPS) achievement tests and the attitudes toward science measure, the results do show that the experimental group BSPS test scores were higher than those for the control group. The results in Table 1 show a significant difference between the experimental and control groups scores on the integrated science process skills (ISPS) achievement test. This data suggests that those students who studied process skills using the self-paced approach performed significantly better when compared to those students using an instructor-paced approach.

TABLE 2

Correlation Coefficients of Dogmatism Scores

With Three Dependent Variables

	BSPS Test Scores	ISPS Test Scores	SAI Scores
Rokeach Dogmatism Score	+ 0.37	- 0.78*	- 0.62*
SAI Scores	- 0.13	- 0.27	

*$p<0.05$

Table 2 shows the correlation coefficients of the Rokeach Dogmatism scores with the BSPS, ISPS and SAI scores. The results indicate that a significant correlation exists between the Rokeach dogmatism scores and both the ISPS and SAI scores. These results suggest that those students who were open-minded achieved significantly higher on the ISPS achievement test and had more positive attitudes toward science than those students considered closed-minded.

DISCUSSION

The effectiveness of any program is determined by student performance and their attitudes toward the program. Since a great deal of emphasis has been given to what is now commonly known as a Competency-Based Teacher Education (CBTE) program, research studies need to be conducted to determine if this program provides more pay off for students than a traditional one. However,

before attempting to do an overall analysis of a CBTE program, it would be prudent to examine each of its component parts to determine if they are, in fact, significantly more effective than their traditional counterparts. In this study the effects of self-pacing on students' achievement and attitudes were examined.

The results obtained in this study on the BSPS achievement test scores support those obtained by Edwards and Powers (1973). They found that self-pacing is no more effective than instructor-paced instruction on student achievement. On the other hand, the experimental group performed significantly better on the ISPS achievement test when compared to the control group. These results could possibly be explained if one considers the order in which the students completed the self-instructional booklets. Since students were required to complete the BSPS book first and the idea of self-pacing was new to them, it is conceivable that once students had the opportunity to work in this kind of setting, they were more self-pace oriented, thus producing the significant differences between the experimental and control groups on the ISPS test scores.

The hypothesis that students in a self-pacing setting will have more positive attitudes toward science than those students in an instructor-paced setting was not supported by this study. The data obtained in Table 1 show that the average score on attitudes toward science was higher for the control

group than for the experimental group. Although the control group had a higher average attitude score than the experimental group, it would be premature to arrive at any cause-effect relationship. A possible explanation for this finding, could be that the span of time covered by this study (one quarter), is not enough time to evaluate attitudinal changes. A longer treatment time may give a better indication. Furthermore, most of the subjects in this investigation held full-time jobs and school seemed to be their secondary goal. A pilot study conducted by the authors indicated that students in this type of educational environment preferred to receive instructions specifying those dates when tasks were due. In addition, the science methods course was part of a science-mathematics block and students expressed negative feelings toward this arrangement. These observations may, then, explain the adverse results obtained on the attitude toward science scores.

Although no significant differences were obtained in students' attitudes toward science, significant correlations were found between students' scores on the Rokeach Dogmatism scale and their scores in the ISPS achievement test and the Scientific Attitude Inventory. This means that those students who were open-minded achieved significantly better and had more positive attitudes toward science than closed-minded students. Most educators would probably agree that not only

is it important to have students demonstrate competency in a teaching skill, but also to have them demonstrate positive attitudes toward the skill as well. Based on data gathered in this study the Rokeach Dogmatism scale is an instrument that can be used as an indication of students' attitudes prior to enrolling in a teacher education program.

In addition, investigations need to be conducted to determine if the length of treatment time is a determining variable toward changing student attitudes toward science. Furthermore, comparative studies need to be conducted between commuter and campus students in order to investigate if they have different attitudes toward self-pacing. Finally, a study similar to the one reported here but with a larger sample is also recommended.

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